

CLAIMS

We claim:

1. A method for managing a data storage system, comprising:

5 configuring a first cache to perform at least one of the operations of retrieving data from and storing data at a first range of logical addresses (LAs) in a storage device;

10 configuring a second cache to perform at least one of the operations of retrieving data from and storing data at the first range of LAs;

15 configuring one or more third caches to perform at least one of the operations of retrieving data from and storing data at a second range of LAs in the storage device;

 detecting an inability of the second cache to retrieve data from or store data at the first range of LAs; and

20 reconfiguring at least one of the first cache and the one or more third caches to perform at least one of the operations of retrieving data from and storing data at the first range of LAs in response to the inability while continuing to perform at least one of the operations of retrieving data from and storing data at
25 the second range of LAs.

2. The method according to claim 1, and comprising configuring one or more interfaces to receive input/output (IO) requests from host processors directed to specified LAs and to direct all the IO requests to the
30 caches which have been configured to perform at least one of the operations of retrieving data from and storing data at the specified LAs.

3. The method according to claim 2, wherein the one or

more interfaces comprise a mapping between the first and the second and the one or more third caches and the first and second ranges of the LAs, and wherein the one or more interfaces are adapted to convert the IO requests to one or more requests and to direct the one or more requests to at least one of the first and the second and the one or more third caches in response to the mapping, and wherein detecting the inability comprises generating a reconfigured mapping between the first and the one or more third caches and the first and second ranges of the LAs, and directing the one or more requests to at least one of the first and the one or more third caches in response to the reconfigured mapping.

4. The method according to claim 1, wherein reconfiguring the at least one of the first cache and the one or more third caches comprises processing data in the first cache and the one or more third caches so as to restore the first cache and the one or more third caches to a state of full data redundancy.

5. The method according to claim 4, wherein processing the data comprises classifying data in the first cache into a plurality of data groups.

6. The method according to claim 5, wherein one of the data groups comprises dirty data, and wherein processing the data comprises storing the dirty data at the one or more third caches.

7. The method according to claim 5, wherein one of the data groups comprises dirty data, and wherein processing the data comprises storing the dirty data at the storage device.

8. The method according to claim 1, wherein reconfiguring the at least one of the first cache and the one or more third caches comprises retaining an initial

configuration of the first cache.

9. The method according to claim 1, wherein reconfiguring the at least one of the first cache and the one or more third caches comprises implementing a minimum
5 redistribution of the first and the second ranges among the first cache and the one or more third caches.

10. The method according to claim 9, wherein implementing the minimum redistribution comprises redistributing the first and the second ranges using a
10 consistent hashing function.

11. The method according to claim 9, wherein implementing the minimum redistribution comprises redistributing the first and the second ranges using a random number function.

12. The method according to claim 1, and comprising providing a system manager which is adapted to configure the first, second and one or more third caches, to detect the inability, and to reconfigure the at least one of the first cache and the one or more third caches.

13. The method according to claim 12, wherein providing the system manager comprises incorporating one or more manager processing units into at least one of the storage device, the first cache, the second cache, and the one or more third caches, and operating the one or more manager
25 processing units in a cooperative manner.

14. A data storage system, comprising:

a storage device wherein data is stored at logical addresses (LAs);

a first cache which is configured to perform at
30 least one of the operations of retrieving data from and storing data at a first range of LAs in the storage device;

a second cache which is configured to perform at least one of the operations of retrieving data from and storing data at the first range of LAs;

5 one or more third caches which are configured to perform at least one of the operations of retrieving data from and storing data at a second range of LAs in the storage device; and

10 a system manager which is adapted to detect an inability of the second cache to retrieve data from or store data at the first range of LAs, and which reconfigures at least one of the first cache and the one or more third caches to perform at least one of the operations of retrieving data from and storing data at the first range of LAs in response to the inability while
15 continuing to perform at least one of the operations of retrieving data from and storing data at the second range of LAs.

15. The storage system according to claim 14, and comprising one or more interfaces which are configured to
20 receive input/output (IO) requests from host processors directed to specified LAs and to direct all the IO requests to the caches which have been configured to perform at least one of the operations of retrieving data from and storing data at the specified LAs.

25 16. The storage system according to claim 15, wherein the one or more interfaces comprise a mapping between the first and the second and the one or more third caches and the first and second ranges of the LAs, and wherein the one or more interfaces are adapted to convert the IO
30 requests to one or more requests and to direct the one or more requests to at least one of the first and the second and the one or more third caches in response to the mapping, and wherein detecting the inability comprises the system manager generating a reconfigured mapping

between the first and the one or more third caches and the first and second ranges of the LAs, and directing the one or more requests to at least one of the first and the one or more third caches in response to the reconfigured mapping.

17. The storage system according to claim 14, wherein reconfiguring the at least one of the first cache and the one or more third caches comprises the first cache processing data therein and the one or more third caches processing data therein so as to restore the first cache and the one or more third caches to a state of full data redundancy.

18. The storage system according to claim 17, wherein processing the data comprises classifying data in the first cache into a plurality of data groups.

19. The storage system according to claim 18, wherein one of the data groups comprises dirty data, and wherein processing the data comprises storing the dirty data at the one or more third caches.

20. The storage system according to claim 18, wherein one of the data groups comprises dirty data, and wherein processing the data comprises storing the dirty data at the storage device.

21. The storage system according to claim 14, wherein reconfiguring the at least one of the first cache and the one or more third caches comprises the first cache retaining an initial configuration.

22. The storage system according to claim 14, wherein reconfiguring the at least one of the first cache and the one or more third caches comprises the system manager implementing a minimum redistribution of the first and the second ranges among the first cache and the one or

more third caches.

23. The storage system according to claim 22, wherein implementing the minimum redistribution comprises redistributing the first and the second ranges using a
5 consistent hashing function.

24. The storage system according to claim 22, wherein implementing the minimum redistribution comprises redistributing the first and the second ranges using a random number function.

10 25. The storage system according to claim 14, wherein the system manager comprises one or more manager processing units which are incorporated into at least one of the storage device, the first cache, the second cache, and the one or more third caches, and wherein the one or more
15 manager processing units operate in a cooperative manner.

26. A storage system, comprising:

one or more mass storage devices, coupled to store data at respective first ranges of logical addresses (LAs);

20 a plurality of interim fast-access-time caches, configured to operate independently of one another, each interim fast-access-time cache being assigned a respective second range of the LAs and coupled to receive data from and provide data to the one or more mass
25 storage devices having LAs within the respective second range; and

one or more interfaces, which are adapted to receive input/output (IO) requests from host processors directed to specified LAs and to direct all the IO requests to the
30 interim fast-access-time cache to which the specified LAs are assigned.

27. The storage system according to claim 27, wherein the mass storage devices comprise fast-access-time mass

storage devices.

28. A method for storing data, comprising:

storing the data in one or more mass storage devices having respective first ranges of logical addresses

5 (LAs);

assigning to each of a plurality of interim fast-access-time caches, configured to operate independently of one another, a respective second range of the LAs;

10 coupling the plurality of interim fast-access-time caches to receive data from and provide data to the one or more mass storage devices having LAs within the respective second range;

receiving input/output (IO) requests from host processors directed to specified LAs; and

15 directing all the IO requests to the interim fast-access-time cache to which the specified LAs are assigned.

29. The method according to claim 28, wherein the mass storage devices comprise fast-access-time mass storage
20 devices.

30. A system for transferring data to and from one or more mass storage devices which store data at respective first ranges of logical addresses (LAs), comprising:

25 a plurality of interim fast-access-time caches, configured to operate independently of one another, each interim fast-access-time cache being assigned a respective second range of the LAs and coupled to receive data from and provide data to the one or more mass storage devices within the respective second range; and

30 one or more interfaces, which are adapted to receive input/output (IO) requests from host processors directed to specified LAs and to direct all the IO requests to the interim fast-access-time cache to which the specified LAs

are assigned.

31. The system according to claim 30, wherein the mass storage devices comprise fast-access-time mass storage devices.

5 32. A method for transferring data to and from one or more mass storage devices which store data at respective first ranges of logical addresses (LAs), comprising:

10 assigning to a plurality of interim fast-access-time caches, configured to operate independently of one another, respective second ranges of the LAs;

coupling the plurality of interim fast-access-time caches to receive data from and provide data to the one or more mass storage nodes having LAs within the respective second ranges;

15 receiving input/output (IO) requests from host processors directed to specified LAs; and

directing all the IO requests to the interim fast-access-time cache to which the specified LAs are assigned.

20 33. The method according to claim 32, wherein the mass storage devices comprise fast-access-time mass storage devices.